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INSTRUCTIONS FOR

DECADE AMPLIFIER

MODEL 220

FOURTH EDITION
SEPTEMBER, 1948

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IMMEDIATE AREA

Ballantine Laboratories, Inc.
Boonton, New Jersey, U. S. A.

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INSTRUCTIONS FOR

DECADE AMPLIFIER

MODEL 220

1. GENERAL.—This instrument is designed to provide stable amplifications of exactly 10 or 100 times over a frequency range extending from 10 to 100,000 cycles. It is operated by self-contained batteries having a life of over 150 hours. Either of the two standard gains, 10× or 100 × may be selected by means of a switch.

While this instrument is of general application it was designed primarily for use with our Model 300 Electronic Voltmeter to permit the measurement of AC voltages below one millivolt. With this combination voltages down to 0.1 millivolt may be read with the 10× gain. Since the gain is exactly 10× the voltmeter is direct reading. Theoretically with the 100× gain voltages down to 0.01 millivolt (10 microvolts) are measurable. It is found, however, that the fluctuation noise level for the frequency range covered is such as to interfere with measurements utilizing the full 100× gain. The presence of the fluctuation noise results in an unsteadiness of the needle. It has been found however that good readings may be obtained down to 20 microvolts, and below, depending upon the impedance of the circuit connected to the input terminals.

The overload limits of the amplifier are set forth below. Input voltages in excess of 100 millivolts should not be applied to the amplifier. Voltages greater than this should be applied directly to the Model 300 Voltmeter.

2. **General Description.**—The amplifier comprises two stages employing miniature type 1T4 tubes. It utilizes special circuits developed originally in these laboratories which stabilize the gain so that the variation of battery voltages during life, changes in tubes and circuit constants, etc., do not affect the gain by more than 1 or 2 percent. The circuits are also equalized so that when the amplifier is connected to an output load comprising the Model 300 Voltmeter the gain is constant within these limits from 10 to 100,000 cycles. With other output loads, particularly if the capacity exceeds 30 $\mu\mu$fds, the variation in gain at the higher frequencies may exceed the 2% limit. The equalization was designed particularly for the Model 300 Voltmeter load.

3. **Operation.**—The instrument is ready to operate as received and is turned on by pulling out the switch located to the left of the meter. The gain is selected by means of the switch to the right of the meter. One side of the input circuit should be grounded, although if the instrument is not used with the Model 300 Voltmeter this may not be necessary since the capacity to ground is very small.

4. **Gain Adjustment.**—The gains are carefully adjusted to within one or two percent before leaving the laboratory. In case, however, these adjustments are accidentally disturbed a screw-driver gain adjustment is provided whereby the proper setting may be restored. This may be carried out with the aid of a Model 300 Voltmeter by connecting a suitable voltage first to the Model 300 instrument and measuring it and then interposing the amplifier and adjusting the gain until the proper output is obtained as indicated by the Model 300 Voltmeter.

5. **Batteries.**—Each tube is provided with a separate 1½ volt Type 742 Eveready battery. Two 67½-volt "B" batteries are used, Eveready Minimax No. 467. A meter is provided on the panel to indicate the condition of the batteries. The meter will read the voltage of one "A" battery when the ON-OFF switch is on the ON position. It indicates the voltage directly. The instrument is adjusted so that the variation in gain is within 1 or 2 percent until the voltage of the battery has dropped to about one volt. At this point the "A" batteries should be replaced. The condition of the "B" battery is indicated by pressing the button (immediately below the meter) marked "Press for B Batt. Test". This button cuts in a resistance of such value that the meter reads the average voltage per cell of the "B" battery. By this means the condition of the "B" battery is indicated on the same scale as the condition of the "A" battery

and when the voltage has dropped to one volt the "B" batteries should be renewed.

It is recommended that the batteries be removed from the case as soon as they become exhausted, otherwise there is a possibility that they may swell and be difficult to remove.

6. **Overload Characteristics.**—The amplifier is accurately linear up to input voltages of 0.1 volt (100 millivolts). This corresponds to an output voltage of 1 volt on the 10× range and 10 volts on the 100× range. No attempt should be made to apply higher voltages than these if the amplifier is used for voltage measurements in conjunction with the Model 300 Voltmeter. If higher voltages are to be measured they should be applied directly to the voltmeter itself. The actual overload point corresponds to an input voltage of 0.45 volt and the amplifier may be used up to this point if linearity is not essential.

7. **Input and Output Impedances.**—The input impedance is that of a resistance of 500,000 ohms shunted by a capacitance of 30 $\mu\mu$fds. This input impedance is chosen to resemble that of the Model 300 Voltmeter so that when the amplifier is interposed between the voltmeter and the circuit conditions will not be changed. The output impedance at 10× gain is 3000 ohms and at 100× gain 1500 ohms.

8. **Shielding.**—When using the extreme sensitivity of the amplifier and especially when measurements are

being made on high impedance circuits it may be necessary to shield the input terminals from extraneous fields.

9. SERVICING.—If trouble develops in the amplifier the condition of the batteries should first be checked. If the batteries are in good condition and there is no evidence of noise or bad connections the tubes should be changed. If this does not clear up the trouble the instrument should be returned to us for inspection and repair. **Do not return the instrument, however, without first writing and explaining the trouble.**

REFERENCE LIST [illegible]TS

Part No.		Resistors		
1	-	1,000,000 ohms, Type EB,	10%,	Allen-Bradley Company
2	-	1,500 ohms, Type 180-BX,	1%,	Shallcross Mfg. Co.
3	-	5,000 ohms, Type C5MP,		P. R. Mallory & Co.
4	-	390,000 ohms, Type EB,	5%,	Allen-Bradley Company
5	-	100,000 ohms, Type 180-BX,	1%,	Shallcross Mfg. Co.
6	-	1,000,000 ohms, Type EB,	10%,	Allen-Bradley Company
7	-	1,000 ohms, Type EB,	10%,	Allen-Bradley Company
8	-	300,000 ohms, Type EB,	5%,	Allen-Bradley Company
9	-	50,000 ohms, Type 180-BX	½%,	Shallcross Mfg. Co.
10	-	5,000 ohms, Type 180-BX	½%,	Shallcross Mfg. Co.
11	-	30,000 ohms, Type EB,	10%,	Allen-Bradley Company
12	-	1,000,000 ohms, Type EB,	10%,	Allen-Bradley Company
13	-	34,000 ohms, Type 170-BX,	½%,	Shallcross Mfg. Co.
14	-	600 ohms, Type 180-BX,	1%,	Shallcross Mfg. Co.

Condensers

100	-	.1 mfd., 200 Volt,	Sprague Type 67P13
101	-	.047 mfd., 200 Volt,	Sprague Type 67P11
102	-	8 mfd., 250 Volt,	Cornell-Dubilier Type BR-845
103	-	.47 mfd., 200 Volt,	Sprague Type 67P17
104	-	12 mfd., 250 Volt,	Cornell-Dubilier Type BR-1225
105	-	.47 mfd., 200 Volt,	Sprague Type 67P17
106	-	80 to 250 mmfd., Mica Compression,	Sickles Type HC
107	-	0 to 30 mmfd., Mica Compression,	Millen Type 28030
108	-	12 mfd., 250 Volt,	Cornell-Dubilier Type BR-1225
109	-	20 mmfd., Centralab Type D midget ceramic	

Batteries

1½ volt - Eveready Type 742
67½ volt - Eveready Type 467

Meter

Weston Model 506, 0-3 volts DC

Tubes

Type 1T4, General Electric Co.

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